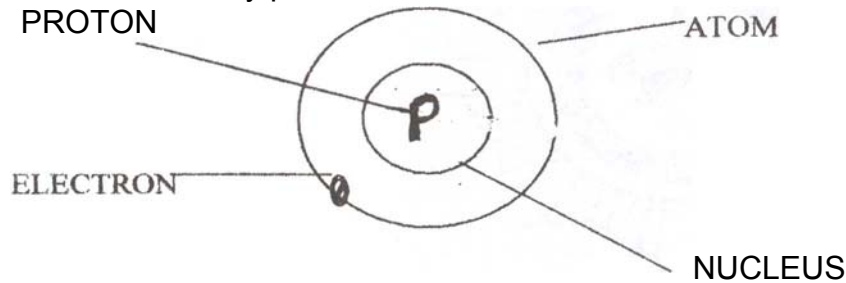


What is Electricity?

It is a movement or flow of tiny particles called electrons.



To get a clearer understanding of this phenomenon, let's investigate the simplest atom, that of the gas hydrogen. The atom consists of a central nucleus around which revolve one planetary electron. The nucleus is at the centre of the atom just as the sun is at the centre of our solar system.

The nucleus contains the protons and neutrons. The proton is positively (+ VE) charged while the neutron carries no charge. The electron, which orbits the nucleus, is negatively (-VB) charged.

The atom is electrically neutral if the number of protons contained in the nucleus is equal to the number of electrons orbiting the nucleus.

The electrons are continuously revolving around the nucleus at random speed and will continue in this motion until they are caused to move from their orbit by one of three methods

- (1) The application of an electric pressure (voltage).
- (2) Thermocouple (heating two dissimilar metals, which are joined together at the junction)
- (3) Exposing the material to light (photo emissive).

OHM'S LAW EXPRESSED IN WORDS

Ohm's states that the current flowing in a circuit is directly proportional to the voltage and inversely proportional to the resistance at a constant temperature

IN SYMBOLS

$$I = V/R$$

Where 'I' is the current in amperes

'V' is the voltage in volts

and 'R' is the resistance in Ohms

(Ω)

ELECTRICAL RESISTANCE

The flow of electric current, like any other flow or movement, is subject to friction. The friction, or opposition, which a material presents to a flow of current, is called resistance. The unit of

electrical resistance is the OHM and the symbol is Ω (Greek letter omega). The capital letter

R is used to denote total resistance and R_1 , R_2 , R_3 etc. are used for individual resistors.

A circuit is defined by the I.E.E regulations as an arrangement of conductors for the

passage of an electric current.

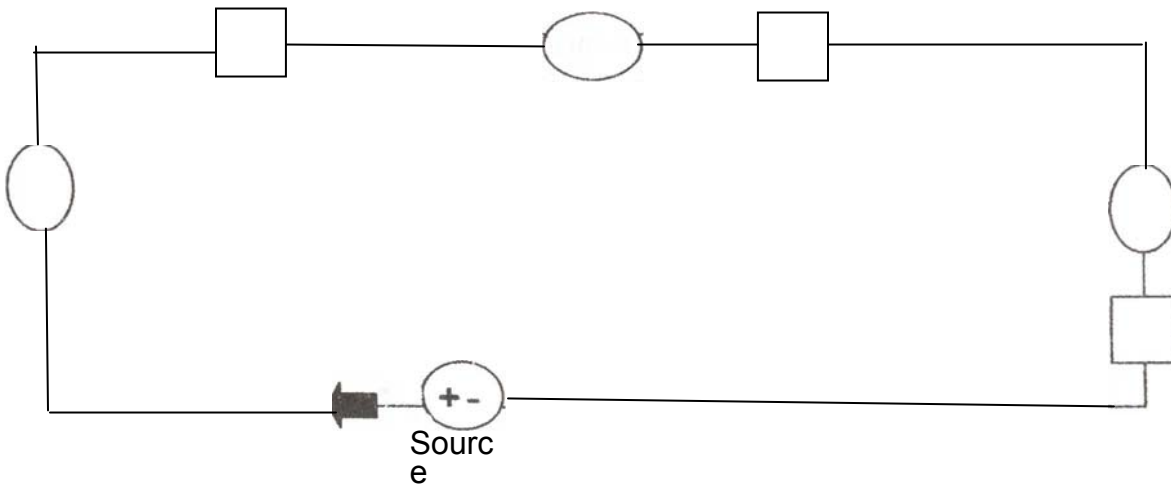
Circuit Configurations

Electric circuits are primarily of two types

- (1) Series Circuits
- (2) Parallel Circuits.

Series Circuits

A circuit is in series when the current flowing in the circuit is the same at all points in the circuit.



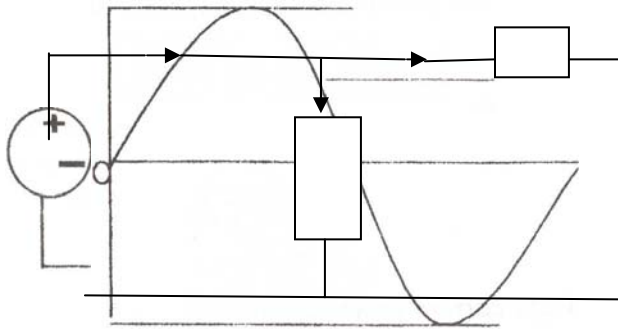
RESISTANCE CALCULATIONS OF SERIES CIRCUITS

The total resistance of a series circuit is given by
 $R_t = R_1 + R_2 + R_3 + R_4 + \dots + R_N$

In a series circuit the voltage shares across each component as determined by the component's resistance value.

PARALLEL CIRCUITS

A circuit is in parallel when the current flowing in the circuit divides at a node or junction in the circuit.




The total resistance of a parallel circuit is given by:

$$1/R_t = 1/R_1 + 1/R_2 + 1/R_3 + \dots + 1/R_N$$

In a parallel circuit the voltage is the same at all points in the circuit while the current shares for each component.

Symbols used for resistors identification.

(1) $\begin{matrix} - & A & A & A & A \\ & V & V & V & V \\ & L & & & L \end{matrix}$
Fixed Resistor

(2) 
Variable Resistors



SHORT CIRCUITS

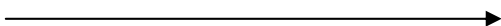
By definition a short circuit is an over current resulting from a fault of negligible impedance between phase conductors or between phase and neutral conductors having a difference in potential under normal operating conditions.

TYPES OF CURRENTS

There are two (2) sources of electricity:

- (1) Direct current (DC)
- (2) Alternating current (AC).

Direct current (DC) is current that flows in one direction only. Chief sources of direct current are the battery and the DC generator.



DC

Alternating current is current or voltage that continuously reversing its direction and magnitude. Source of alternating current - AC generator.

MAX VALUE
+

Sine
Wave

MAX VALUE

Of the two sources of alternating current is more widely used. This is so because of the low cost of production and transmission and the convenience of distribution.

CONDUCTORS AND

INSULATORS CONDUCTORS

A conductor is a material that offers a low resistance to the flow of an electric current e.g. of conductors are:

1. Silver
2. Copper
3. Gold
4. Aluminium etc.

Conductors formed the medium between the point of generation and the point of utilization.

INSULATORS

An insulator is a material that offers a high resistance to the flow of an electric current. e.g. of insulators are :

1. Rubber
2. Polyvinyl chlorjde (PVC)
3. Wood (dry)
4. Dry paper
5. Porcelain etc.

PROTECTION FROM EXCESS CURRENT

Excess current may flow in a circuit as a result of an overload or a short circuit.

A circuit is said to be overload when the rated value of the current designed for the circuit is exceeded.

Overload currents usually occur in a circuit because the consumer abuses it or because it has been badly designed or modified by the installer.

Short circuit usually occur as a result of an accident, which could not have been predicted before he event.

in both cases the basic requirement for protection is that the circuit should be interrupted before the fault causes a temperature rise, which might damage the insulation terminations joints or the surrounding of the conductors or even cause a fire.

types of protection for electric circuits fall in three categories

1. Electromagnetic (circuit breakers)
2. Fuses (conducting element)
3. Thermal (Bi-metallic strip being heated)

EARTHING

The earth is a huge reservoir. It is essential that all leakage current go to earth. The I.E.E regulations require all metallic parts forming part of an electric circuit to be earthed. This is to ensure that there is no potential existing between the metal part and the general mass of earth.

TRANSFORMERS

A transformer is a device, which is used to change the voltage values in a circuit. The transformer consists of three basic parts (1) the iron core (2) primary winding (3) secondary winding.

TERMINOLOGIES DEFINED

Circuit-breaker. A mechanical device for making and breaking a circuit, both under normal conditions and under abnormal conditions, such as those of a short circuit, the circuit being broken automatically.

Danger. Danger to health or danger to life or limb from shock, burn, or other injury to persons (and livestock where present,) or from fire, attendant upon the use of electrical energy.

Dead. At, or about earth potential and disconnected from any live system.

Distribution board. An assemblage of parts, including one or more fuses or circuit-breakers, arranged for the distribution of electrical energy to final sub-circuits or to other distribution boards.

Earth-continuity conductor. The conductor, including any clamp, connecting to the consumer's earthing terminal, or to the Frame terminal or a voltage-operated earth-leakage circuit-breaker, or to each other those parts of an installation which are required to be earthed. It may be in whole or in part the metal conduit, trunking, or duct, or the metal sheath and/or armouring of a cable, or the special earth-continuity conductor of a cable or flexible cord incorporating such a conductor.

Earth electrode. A metal rod or rods, a system of underground metal pipes or other conducting object, providing an effectual connection with the general mass of the earth.

Earthed. Effectually connected to the general mass of the earth.

Earth lead. The final conductor by which the connection to the earth electrode, or other means of earthing, is made.

Flameproof. Applied to apparatus to denote that the containing case or other enclosure will withstand without injury any explosion of prescribed flammable gas that may occur within it under practical conditions of operation within the rating of the apparatus (and recognized overloads, if any, associated therewith) and will prevent the transmission of flame such as will ignite any prescribed flammable gas that may be present in the surrounding atmosphere.

Flammable. A flammable material is one capable of being easily ignited.

Fuse. A device for opening a circuit by means of a fuse-element designed to melt when an excessive current flows. It normally consists of a fuse-base and fuse-link. The fuse-link may take the form of a cartridge or a carrier supporting a fuse-element. For the purpose of these Regulations, the current rating of a fuse is a current less than the minimum/using current, stated by the marker as the current that the fuse and the fuse-link with which it is fitted will carry continuously without deterioration.

Intrinsically safe.

(1) Applied to a circuit, denotes that any electrical sparking that may occur in normal working under the conditions specified by the certifying authority, and with the prescribed components, is incapable of causing an ignition of the prescribed flammable gas or vapour.

(2) Applied to apparatus, denotes that it is constructed that when installed and operated under the conditions specified by the certifying authority, any electrical sparking that may occur in normal working, either in the apparatus or in the circuit associated therewith, is incapable of causing an ignition of the prescribed flammable gas or vapour.

Isolator. A mechanical device capable of opening or closing a circuit under conditions of no load or negligible current.

Live. In relation to a conductor, means that, under working conditions

- (a) a difference of voltage exists between the conductor and earth, or
- (b) it is connected to the middle wire, common return wire or neutral wire of a supply system in which that wire is not permanently and solidly earthed.

Non-combustible. A non-combustible material is one which is not capable of undergoing combustion and satisfies the performance requirements specified in the non-combustible test of B.S. 476- 'Fire tests all building materials and structures, Part 4-Non-combustibility test for materials '.

Plug. A device intended for connection to a flexible cord or flexible cable which can be engaged manually with a socket-outlet or connector or adaptor and which has current-carrying contact pins which may be exposed when not engaged.

Switchgear. Apparatus for controlling the distribution of electrical energy, or for controlling or protecting electrical circuits, machines, and current-using appliances.

Voltage (Nominal). Voltage by which an installation (or part of an installation) is designated. The following ranges of nominal voltage (r.m.s. values for a.c.) are defined: Extra-low. (Band J) Normally not exceeding 50 volts (100 volts for d.c.) whether between conductors or to earth. . Low (Band 2) Normally exceeding extra-low voltage but not exceeding 1 000 volts (1500 volts for d. c.) between conductors and earth.

NOTE - The actual value of the voltage in the installation may differ from the nominal voltage by a quantity within 1101"1111 tolerances.